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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:

Applicants	:	Sadeg M. Faris, et al.
Serial No.	:	09/689,318
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Title of Invention:	:	FUEL CELL SUPPORT AND ELECTRICAL INTERCONNECTOR
Examiner	:	~~not yet assigned~~ Yuan
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Honorable Commissioner of Patents
and Trademarks
Washington, DC 20231

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. 1.97

Sir:

In order to fulfill Applicants' continuing obligation of candor and good faith as set forth in 37 C.F.R. 1.56, Applicants submit herewith an Information Disclosure Statement prepared in accordance with 37 C.F.R Sections 1.97, 1.98 and 1.99.

The disclosures enclosed herewith are as follows:

U.S. PUBLICATIONS

NUMBER	FILING DATE	TITLE
6,057,052	March 3, 1998	CELL FOR A METAL-AIR BATTERY
5,978,283	July 2, 1998	CHARGE PUMP CIRCUITS
5,904,999	December 9, 1997	AIR-COOLED METAL-AIR BATTERY
5,771,476	December 29, 1995	POWER CONTROL SYSTEM FOR A FUEL CELL POWERED VEHICLE
5,756,228	September 12, 1996	ELECTROCHEMICAL DEVICE FOR GENERATING DIRECT CURRENT
5,726,551	October 21, 1996	BATTERY CHARGING DEVICE HAVING TIME SHARED CHARGING CYCLE
5,721,064	May 21, 1996	AIR MANAGER SYSTEM FOR REDUCING GAS CONCENTRATIONS IN A METAL-AIR BATTERY
5,711,648	November 12, 1996	BATTERY CHARGING AND TRANSFER SYSTEM
5,691,074	October 18, 1995	DIFFUSION CONTROLLED AIR VENT FOR A METAL-AIR BATTERY
5,599,637	October 11, 1995	PERFORMANCE ZINC ANODE FOR BATTERIES
5,582,931	April 3, 1995	RECTANGULAR CELL
5,569,551	April 24, 1995	Dual Air Electrode Cell

5,554,452	September 22, 1994	METAL-AIR BATTERIES HAVING IMPROVED AIR ACCESS VALVES
5,536,592	April 25, 1994	GALVANIC BATTERY WITH REPLENISHABLE ELECTRODES AND/OR ELECTROLYTE FOR EXTENDED BATTERY OPERATION
5,525,441	June 11, 1996	FOLDED ELECTRODE CONFIGURATION FOR GALVANIC CELLS
5,512,384	May 18, 1995	BATTERY AND METHOD OF BATTERY CONTROL FOR ENHANCING ELECTROCHEMICAL REACTIONS
5,486,429	April 24, 1995	DIFFUSION VENT FOR A RECHARGEABLE METAL-AIR CELL
5,462,816	October 27, 1994	AIR CELL
5,447,805	July 15, 1994	CELL FOR A METAL-AIR BATTERY
5,439,758	June 23, 1993	ELECTROCHEMICAL POWER GENERATING SYSTEM
5,418,080	July 1, 1994	MECHANICALLY RECHARGEABLE, ELECTROCHEMICAL METAL-AIR BATTERY
5,411,592	June 6, 1994	APPARATUS FOR DEPOSITION OF THIN-FILM, SOLID STATE BATTERIES
5,405,713	September 15, 1993	REFUELING SYSTEM
5,389,456	February 14, 1994	METHOD AND CLOSING PORES IN A THERMALLY SPRAYED DOPED LANTHANUM CHROMITE INTERCONNECTION LAYER
5,387,477	June 25, 1993	AIR MANAGER SYSTEM FOR METAL-AIR BATTERY
5,366,822	March 15, 1994	CELL FOR A METAL-AIR BATTERY
5,362,577	June 4, 1993	DIFFUSION VENT FOR A RECHARGEABLE METAL-AIR CELL
5,360,680	October 21, 1992	MECHANICALLY RECHARGEABLE ELECTRIC BATTERIES AND ANODES FOR USE THEREIN
5,354,625	March 16, 1992	METAL-AIR POWER SUPPLY AND AIR-MANAGER SYSTEM, AND METAL-AIR CELL FOR USE THEREIN
5,328,777	July 14, 1992	CATHODE COVER FOR METAL-AIR CELL
5,328,778	August 10, 1993	METAL-AIR CELLS COMPRISING COLLAPSIBLE FOAM MEMBERS AND MEANS FOR MINIMIZING INTERNAL PRESSURE BUILDUP

5,318,861	January 11, 1993	ELECTROCHEMICAL METAL-AIR CELL AND ELECTRICALLY AND MECHANICALLY RECHARGEABLE ANODES FOR USE THEREIN
5,312,701	May 18, 1993	PROCESS FOR PREPARING A SINGLE PASS GAS DIFFUSION ELECTRODE
5,306,579	October 30, 1992	BIFUNCTIONAL METAL-AIR ELECTRODE
5,260,144	March 22, 1990	METAL/AIR BATTERY WITH SEEDED RECIRCULATING ELECTROLYTE
5,250,370	July 23, 1992	VARIABLE AREA DYNAMIC BATTERY
5,242,765	June 23, 1992	GAS DIFFUSION ELECTRODES
5,196,275	December 31, 1990	ELECTRICAL POWER STORAGE APPARATUS
5,190,833	December 31, 1990	ELECTRODES FOR METAL/AIR BATTERIES AND FUEL CELLS AND BIPOLAR METAL/AIR BATTERIES INCORPORATING THE SAME
5,185,218	December 31, 1990	ELECTRODES FOR METAL/AIR BATTERIES AND FUEL CELLS AND METAL/AIR BATTERIES INCORPORATING THE SAME
5,121,044	June 19, 1990	ELECTRICAL ENERGY STORED
4,968,396	January 30, 1989	METHOD OF AND ELECTROLYTIC-CATALYTIC CELL FOR IMPROVING THE COMPLETION OF COMBUSTION OF OXYGENATED HYDROCARBON FUELS BY CHEMICALLY MODIFYING THE STRUCTURE AND COMBUSTIBILITY THEREOF, INCLUDING THROUGH DEVELOPING HYDROXYL IONS THEREIN
4,957,826	April 25, 1989	RECHARGEABLE METAL-AIR BATTERY
4,950,561	June 29, 1989	METAL-AIR BATTERY WITH EASILY REMOVABLE ANODES
4,916,036	October 20, 1988	CONTINUOUS CONSUMABLE ANODE
4,913,983	September 13, 1988	METAL-AIR BATTERY POWER SUPPLY
4,828,939	June 1, 1987	BIPOLAR METAL/AIR BATTERY
4,714,662	May 17, 1987	POWER MODULE ASSEMBLY OF ELECTROCHEMICAL CELLS
4,693,946	March 11, 1986	BATTERY WITH MODULAR AIR CATHODE AND ANODE CAGE
4,689,531	July 1, 1985	ELECTRIC REGENERATION

		APPARATUS AND METHOD FOR DRIVING A LOAD
4,626,482	November 18, 1985	METAL/AIR BATTERIES
4,560,626	September 20, 1982	RAPIDLY REFUELABLE FUEL CELL
4,551,399	May 31, 1984	BIPOLAR BATTERY
4,341,847	October 14, 1980	ELECTROCHEMICAL ZINC-OXYGEN CELL
4,331,742	December 24, 1980	SOLID ELECTROLYTE CELL
4,246,324	April 9, 1979	CONSUMABLE REPLACEABLE ANODES FOR BATTERIES
4,172,924	February 21, 1978	AIR BATTERY AND ELECTROCHEMICAL METHOD
4,152,489	August 26, 1977	MULTI-PLY LAMINAR PASTED AIR ELECTRODES
4,052,541	December 1, 1975	ELECTRIC ACCUMULATOR CELL WITH AT LEAST ONE DISSOLUBLE ELECTRODE
3,977,901	October 23, 1974	METAL/AIR CELLS AND IMPROVED AIR ELECTRODES FOR USE THEREIN
3,963,519	August 3, 1971	METAL/AIR CELL
3,928,072	July 18, 1974	AIR DEPOLARIZED ELECTRIC CELL
3,909,685	October 16, 1974	ELECTRICAL APPARATUS
3,845,835	March 14, 1973	ELECTRIC POWER PLANT FOR LAND VEHICLES
3,822,149	February 17, 1972	RECHARGEABLE ZINC ELECTROCHEMICAL ENERGY/CONVERSION DEVICE
3,717,505	June 25, 1970	ELECTROCHEMICAL CELL STACK
3,663,298	March 3, 1970	ROTATABLE ELECTRODE STRUCTURE WITH CONDUCTIVE PARTICLE BED
3,577,281	April 28, 1969	RECHARGEABLE MOVING TAPE CELL
3,536,535	November 25, 1969	ELECTRIC POWER SOURCE WITH MOVABLE ANODE MEANS
3,532,548	October 25, 1966	ELECTROCHEMICAL CELL-UTILIZING THREE ELCTRODES
3,454,429	March 29, 1966	METHOD OF GENERATING ELECTRICITY IN TAPE TYPE FUEL CELL
3,436,270	December 30, 1965	OXYGEN DEPOLARIZED CELL AND METHOD OF PRODUCING ELECTRICITY THEREWITH

3,432,354	August 15, 1966	ELECTROCHEMICAL POWER SUPPLY WITH MOVABLE ANODE MATERIAL
3,357,864	December 11, 1964	PRIMARY BATTERY HAVING ONE OF THE ELECTRODES WOUND UP ON A ROTATABLE SHAFT
3,260,620	October 22, 1962	TAPE FED FUEL CELL
3,252,838	January 12, 1962	FUEL CELL HAVING ROTATABLE ELECTRODE

FOREIGN PUBLICATIONS

NUMBER	PUBLICATION DATE	TITLE
UK 1,176,488	December 13, 1966	IMPROVEMENTS IN OR RELATING TO ELECTROCHEMICAL CELLS

TECHNICAL PUBLICATIONS

"Convert 3V To 5V Without Inductors" by , Maxim Integrated Products; http://www.maxim-ic.com, Vol. 92, pages 1-3.

"Derive 5V From Four AA Cells" by , Maxim Integrated Products; http://www.maxim-ic.com, Vol. 128, pages 1-2.

"Boost/Linear Regulator Derives 5B From Four Cells" by , Maxim Integrated Products, http://www.maxim-ic.com.

"Fuel Cell Technology & Applications, http://www.metallicpower.com/rtfuel.htm" by , Metallic Power, Inc..

"FUEL CELLS AND THEIR APPLICATIONS" by Karl Kordesch and Gunter Simader, VCH Publishers, Inc., New York NY, Chapters 4.8.1-4.8.2, pages 158-162.

"FABRICATION OF THIN-FILM LIMN204 CATHODES FOR RECHARGEABLE MICROBATERIES" by F.K. Shokoohi, J.M. Tarascon and B.J. Wilkens, Applied Physics Letters, pages 1260-1262.

"NEW AGE EVs" by Herb Schuldner, Popular Mechanics, pages 27-29.

"BATTERY CHARGERS" by Mike Allen, Popular Mechanics, pages 30-31.

"Marketing Study for AER Energy Resources, Inc." by Authors not indicated, AER Energy Resources, Inc., pages 6-28.

"ELECTRIC CAR SHOWDOWN IN PHOENIX" by Rick Cook, Popular Science, pages 64-65,82□.

"LBL RESEARCHERS WORK ON NEW GENERATION OF BATTERIES" by Jeffery Kahn, www.lbl.gov/Science-Articles/Archive/battery-development-at-lbl.html, pages 1-6.

"BATTERIES FOR CORDLESS APPLIANCES" by Ralph J. Brodd, Ch. 3 of Batteries for Cordless Appliances, pages 49-59.

U.S. Letters Patent No. 5,726,551 to Miyazaki et al. discloses a battery charging unit with a charge controlling unit which is designed to perform at least one of rest mode operating function which causes to rest charging for respective battery, groups and discharge mode operating function which causes to discharge electric power from the respective battery groups in addition to charge mode operating function for the respective battery groups, the battery charging unit controls charging for the respective battery groups through the charge controlling unit while repeating at least two modes including the charging mode among the charging mode, rest mode and discharge mode in a predetermined time cycle and further performs a mutual control between the respective battery groups so that at least one battery group is placed in the rest mode in a predetermined sequence during the operation thereof, thereby, drawbacks of a conventional pulse like charging and burp charging, which are suitable for a quick charging but requires a large instantaneous charging current which causes the size increase of the charging unit and the electric circuit concerned, are eliminated.

U.S. Letters Patent No. 5,721,064 to Pedicini, et al. discloses a rechargeable metal-air battery system having a housing, at least one metal-air cell positioned within the housing, and an air flow path through the housing. An air movement device is provided for communication with the housing and creating a pulsating air flow within the air flow path so as to direct the flow of gases (e.g. oxygen and hydrogen) generated during cell charging operations, and reduce the concentrations thereof within the metal-air battery and thereby improve the performance of the system.

US Letters Patent No. 5,711,648 to Hammerslag discloses a battery transfer and charging system for electric vehicles. As disclosed, the system includes a conveyor loop for conveying batteries from a battery receiving station to a battery delivery station. A displacement assembly removes spent batteries from electric vehicles by forcing.

U.S. Letters Patent No. 5,691,074 discloses a ventilation system for a metal-air battery having a housing for enclosing at least one metal-air cell.

U.S. Letters Patent No. 5,599,637 to Pecherer, et al. discloses a zinc battery anode, which comprises a substantially planar skeletal frame including conductive metal and having a portion of its surface area formed as open spaces. As disclosed, the zinc battery anode further comprises an active zinc anode component encompassing the skeletal frame, and the active anode component is formed of a slurry of porous granules comprising zinc, impregnated with and suspended in an electrolyte, and compacted under pressure to the skeletal frame.

US Patent No. 5,582,931 to Kawakami discloses in Fig. 2A, a strip of insulating substrate material (200) on either side of which a current collector (202, 204) is disposed. As disclosed, the positive electrode (201), made from positive electrode material, is disposed on current collector 202, whereas a negative electrode (203) made of negative electrode material is disposed on current collector (204). As shown in Fig. 3, the insulating substrate (200) is folded to form a battery cell with an insulating layer (300) containing electrolyte disposed between positive and negative electrodes (201) and (203), respectively.

U.S. Letters Patent No. 5,569,551 to Pedicini et al. discloses a dual air electrode metal-air cell having a casing including an upper cathode mask wall, a lower cathode mask wall, and a plurality of side walls. A metal anode having upper and lower sides is covered with separator materials comprising one or more layers of an absorbent fibrous web and one or more layers of a microporous membrane that, when wet, is gas-impermeable and liquid-permeable. An upper air cathode is positioned between the upper cathode mask wall and the separator materials on the upper side of the metal anode. A lower air cathode is positioned between the lower cathode mask wall and the separator materials on the lower side of the metal anode. A liquid electrolyte is substantially trapped by the separator materials. A gas vent is positioned on one or more side walls of the casing.

U.S. Letters Patent No.5,554,452 to Delmolino, et al. discloses a prismatic metal-air battery having at least one prismatic metal-air cell received in a cell cavity of a prismatic casing. The casing comprises a wall portion which defines a surface. The wall portion has at least one opening in communication with the cell cavity which is adapted to allow the passage of air into the cell cavity The casing also includes a valve member having a surface bearing on the wall portion surface. The valve member also has at least one opening therein. The wall portion surface and the valve member surface are adapted to allow movement of the valve member across

the wall portion surface between a closed position. As disclosed, the valve member opening does not overlap with the wall position opening and an open position, whereas the valve member opening and wall portion opening at least partially overlap.

U.S. Letters Patent No. 5,536,592 to Celeste et al. discloses a galvanic battery which supplies the anode and/or cathode from an elongated strip of flexible tape. As disclosed, the flexible tape is preferably interconnected through a strip of inactive material which functions as a leader and separates the tape entering the electrochemically active compartment of the battery housing from spent tape exiting the electrochemically active compartment. The battery is preferably constructed to include a supply reel having a rotatable core upon which said strip of tape is wound in a cylindrical configuration with the inner winding of tape extending from said core and being thread through said electrochemically active compartment before being connected back into the electrochemically inactive compartment and wound as the outer winding around the core of the supply reel.

U.S. Letters Patent No. 5,525,441 to Reddy et al. discloses a high density cell stack which comprises utilizing strips of flexible cathode material and flexible anode materials folder over each other at right angles. As disclosed, a suitable anode material is lithium and a suitable cathode material is manganese dioxide. As disclosed, the cell stacks can be rapidly manufactured to provide high density cells with good mechanical stability and good stability against shorting.

U.S. Letters Patent No. 5,512,384 to Celeste et al. discloses a battery which includes an anode and cathode structure spaced a fixed distance apart, and a movable conveyor having an electrolyte impregnated therein. As disclosed, the battery also includes a mechanism for advancing the movable conveyor to engage the anode and/or cathode at the anode and/or cathode interface, with the electrolyte. As disclosed, the moving conveyor containing the electrolyte is progressively advanced through the interface spacing between the anode and the cathode while the interface spacing is maintained substantially constant even as the anode is consumed. Battery operation is terminated by separating the engaging surfaces of the anode and/or cathode from the moving conveyor and is reestablished by re-engaging the anode and/or cathode surfaces with the moving conveyor.

U.S. Letters Patent No. 5,486,429 to Thibault discloses ān diffusion-type venting for use in metal-air fuel cell battery systems having a housing containing a metal-air cell with a cathode and an anode having a separator positioned therebetween. As disclosed, the diffusion-type venting system includes a gas vent having a gas vent cap which prevents the anode from blocking the venting of gas through a gas permeable hydrophobic membrane.

U.S. Letters Patent No. 5,462,816 to Okarmura et al. discloses a metal-air cell having a single cell or a plurality of cells aggregated together. As disclosed, a separator is disposed between the positive electrode and the negative electrode of each cell and is composed of a water absorbing material that absorbs and holds an electrolytic solution. An electrolytic solution supply member is disposed at a lower edge of the positive electrode and the negative electrode and is adapted to supply the electrolytic solution to the separator. A spacer covers an outer surface of the positive electrode and the negative electrode and forms an air layer on the front surface thereof.

U.S. Letters Patent No. 5,447,805 to Harats et al. discloses a modular cell for a multi-cell metal-air battery system, comprising a relatively flat cell housing having two major surfaces and accommodating a pair of oppositely disposed, spaced-apart, air-permeable, liquid-impermeable cathodes in the form of air electrodes defining between themselves a space open towards the upper edges of the cell housing and closed at the lateral edges and the bottom of the cell housing, the space being configured to accommodate an anode of said battery, substantial portions of the major surfaces of the housing being removed, thus exposing major portions of the air electrodes. The two major surfaces of the housing are partly recessed in such a way as to form, in conjunction with a similarly recessed outer surface of a major wall of an adjacent cell housing, an air space with air access and exits, and the exposed portions of the air electrodes are supported and reinforced by ribbing constituted at least by a plurality of slender rails, which rails define ducts for guiding a flow of air across the portions of the air electrodes from the air access toward the exits. An upper portion of at least one major surface of the housing is provided with a fluid flow channel having an inlet and an outlet provided in a wall of a minor surface of the housing for guiding a cooling fluid introduced into the inlet across an upper area of the cell, in heat exchange with electrolyte contained in upper portions of the open space, via an inner wall of the housing

portion.

U.S. Letters Patent No. 5,439,758 to Stone et al. discloses an electrochemical power generating system which has a base unit and a replaceable fuel unit. The base unit comprises a controller for controlling operation of the pump. The fuel unit comprises a second housing releasably connectable to the first housing and a row of metal-air cells in the second housing electrically inter-connected together. Each cell includes a casing, a metal anode within the casing, an air cathode, a spacer between the cathode and anode for preventing the anode from contacting the cathode, an electrolyte intake port, and an electrolyte discharge port in the casing for passage of electrolyte through the casing and between the anode and cathode. The fuel unit further comprises a manifold, an electrolyte reservoir, and fluid line. The manifold has an intake port and a plurality of discharge ports in fluid communication with the electrolyte intake ports of the cells so that electrolyte flowing through the manifold is directed through the intake ports of the cells. The electrolyte reservoir and intake port of the manifold are operatively connectable with the electrolyte pump for fluid communication therewith so that the pump is able to pump electrolyte from the reservoir to the manifold. The fluid line operatively connects the discharge ports of the cells with the reservoir so that electrolyte discharged from the cells flows to the reservoir. The replaceable fuel unit is releasably attachable to the base unit so that the fuel unit can be quickly attached to and detached from the base unit.

U.S. Letters Patent No. 5,418,080 to Korall et al. discloses a mechanically rechargeable, electrochemical metal-air battery of the type having a plurality of metal-air cells, each of said cells comprising (a) a housing having a base, two major surfaces and two minor surfaces, defining an interior space for containing therein a replaceable metal electrode having an electrically conductive skeletal member encompassed by an active metal component, the interior space communicating with an opening opposite the base through which the replaceable metal electrode is selectively removed to enable the mechanical replacement thereof with a freshly charged metal electrode; (b) at least one generally planar, air permeable but liquid impermeable, air electrode, each of the electrodes being installed in a window-like opening provided in at least one of the major surfaces; and (c) an electrolyte in contact with the metal and air electrodes; a first woven mesh separator is attached to an inner, electrolyte-facing surface of each of the air electrodes and a second woven mesh separator is attached to and covering a major surface of the replaceable metal electrode facing each of the air electrodes, the first and second woven mesh separators being in sliding relationship to each other.

U.S. Letters Patent No. 5,411,592 to Ovshinsky et al. discloses a multi-chambered deposition apparatus for depositing solid-state, thin-film battery materials onto substrate material. The apparatus minimally includes at least three distinct evacuable deposition chambers, which are physically interconnected in series. The first deposition chamber is adapted to deposit a layer of battery electrode material having a first polarity onto the substrate. The second deposition chamber is adapted to deposit a layer of solid-state electrolyte material onto the layer of battery electrode material deposited in the first chamber. The third deposition chamber is adapted to deposit a layer of battery electrode material having an opposite polarity from that deposited in the first chamber onto the solid-state electrolyte. The deposition chambers are interconnected by gas gates such that the substrate material is allowed to proceed from one deposition chamber to the next, while maintaining gaseous segregation between the chambers.

U.S. Letters Patent No. 5,405,713 to Pecherer et al. discloses a refueling system for automated recharging of zinc-air batteries of the type having a plurality of active zinc anode elements formed of active zinc material attached to a support frame immersed in an aqueous alkaline electrolyte in a battery casing, each anode element being in alternate array with an air cathode, the system comprising automated means for simultaneously separating a plurality of spent anodes from the casing, means for removing used electrolyte from the casing, transport means for conveying spent anodes to an anode processing station, the anode processing station, at which zinc which has been at least partly oxidized is removed from the support frame, means for attaching new or reconstituted active zinc material to a cleaned support frame to form an active zinc anode, automated means for simultaneously introducing a plurality of active zinc anodes into the casing, and means for introducing fresh electrolyte into the casing.

U.S. Letters Patent No. 5,389,456 to Singh et al. discloses in Fig. 1 an air electrode structure for use in a hydrogen/oxygen type fuel cell system. As disclosed, a solid electrolyte layer can be applied to a portion of the air electrode, and a fuel electrode can be applied to the solid electrolyte, to form an electrochemical cell for generation of electrical power.

U.S. Patent No. 5,387,477 to Cheiky discloses in Fig. 1 an air manager system for use in a metal-air battery. As disclosed in Fig. 2, two metal-air cells 12 are stacked one above the other. Each cell 12 consists of a cell body 13, which includes an air cathode (not shown) in the bottom area of the cell body, and a cathode air duct 14 which provides an air chamber above the air cathode. A cooling air plenum 18 is attached to the side of the power supply 10 and extends to cover the cooling air channels 16. One or more cooling air fans 20 are positioned at the opening of the plenum 18, which directs air from the fans 20 into and through the channels16. The cooling air exits the channels 16 at the other end (not shown) of the cell bodies and is exhausted from the system.

U.S. Letters Patent No. 5,366,822 to Korall et al. discloses a modular cell for a multi-cell metal-air battery system, the cell comprising a relatively flat cell housing having two major surfaces and accommodating a pair of oppositely disposed, spaced-apart, air-permeable, liquid-impermeable cathodes in the form of air electrodes defining between themselves a space open towards the upper edges of the cell housing and closed at the lateral edges and the bottom of the cell housing, the space being configured to accommodate an anode of said battery, substantial portions of the major surfaces of the housing being removed, thus exposing major portions of the air electrodes. The two major surfaces of the housing are partly recessed in such a way as to form, in conjunction with a similarly recessed outer surface of a major wall of an adjacent cell housing, an air space with air access and exits, and the exposed portions of the air electrodes are supported and reinforced by ribbing constituted at least by a plurality of slender rails, which rails define ducts for guiding a flow of air across the portions of the air electrodes from the air access toward the exits.

U.S. Patent No. 5,362,577 to Pedicini discloses a diffusion vent for a rechargeable metal-air cell, similar to the diffusion vent disclosed in US Patent No. 5,486,429. As disclosed in Fig. 2, the metal-air cell 14 includes a cell case 12 having a case body 18 consisting of a horizontal grid 19 defining a plurality of openings 20, and an upwardly extending peripheral side wall 21. An air cathode 22 is disposed within the cell case body 18, along the bottom of the cell case body 21. The openings 20 expose the cathode 22 to the atmosphere. A gas-permeable, hydrophobic membrane 23 extends along the interior of the cell case 12 between the cathode 22 and the openings 20 and along the sidewall 21 to prevent electrolyte leakage and/or moisture from exiting the cell 14, while allowing air to pass through for reaction at the cathode 22.

U.S. Letters Patent No. 5,360,680 to Goldman et al. discloses a mechanically rechargeable electric battery including at least one electrical cell which has a pair of generally planar outer electrodes configured to define therebetween an interior space for an electrical power storage medium, and inner electrodes removably-mounted between the pair of outer electrodes so as to be in electrically conductive contact with the electrical power storage medium and configured to provide mechanical support for the electrical power storage medium and to be removable as a unit therewith from the cell. The cell is a metal-gas battery cell and the electrical power storage medium contained in the interior space contains a slurry containing active porous zinc particles saturated with an electrolyte solution. The outer electrodes define an opening communicating with the interior space, and the inner electrodes are configured for their removal from the interior space, via the opening, thereby enabling the simultaneous removal of the inner electrodes and the slurry from the interior space.

U.S. Letters Patent No. 5,354, 625 to Bentz discloses a metal-air fuel cell battery system having a metal-air power supply and air-manager system, and metal-air cell used therein. As disclosed, the metal-air power supply and air-manager system provides isolates the exhausted reactant and cooling portions of air flow in the system by separating the reactant air inlets from and the cooling air inlets, and thus improving air flow control during system operation.

U.S. Patent No. 5,328,777 to Bentz et al. discloses in Fig. 1 a metal-air cell battery system having an air cathode cover 10 which includes a rectangular mask member 13 and a wall extending from the peripheral edges of the mask member to form an elongated tray-shaped structure that fits over the cathode structure 64 of the metal-air cell 19. As disclosed, the mask member 13 controls the amount of air to which the internal components of the metal-air cell (e.g. cathode and anode elements) are exposed during power generation.

U.S. Patent No. 5,328,778 to Woodruff et al. discloses a prismatic zinc-air fuel cell comprising a prismatic container having therein an air cathode, a separator and a zinc anode. The

container has one or more oxygen access openings, and the air cathode is disposed in the container in gaseous communication with the oxygen access openings so as to allow access of oxygen to the cathode. The separator has a first side in electrolytic communication with the air cathode and a second side in electrolytic communication with the zinc anode. The separator isolates the cathode and the zinc anode from direct electrical contact and allows passage of electrolytes therebetween. An expansion chamber adjacent to the zinc anode is provided which accommodates expansion of the zinc anode during discharge of the cell. A suitable collapsible foam member generally occupies the expansion space, providing sufficient resistance tending to oppose movement of the zinc anode away from the separator while collapsing upon expansion of the zinc anode during discharge of the cell. One or more vent openings disposed in the container are in gaseous communication with the expansion space, functioning to satisfactorily minimize the pressure buildup within the container by venting gasses expelled as the foam collapses during cell discharge.

U.S. Letters Patent No. 5,318,861 to Harats et al discloses a metal-air cell for multiple discharge and recharge cycles including a housing for accommodating a replaceable metal electrode (having a generally planar electrically conductive skeletal member encompassed by an active metal component). At least one air cathode (generally planar) is installed at at-least one of the sides of the housing. An electrolyte is provided in contact with the metal and air electrodes. One or more auxiliary charging anode electrodes are provided that are selectively engaged (by a relay circuit), and the air cathode is disengaged, so that current flows to the charging anode electrode(s).

U.S. Letters Patent No. 5,312,701 to Khasin et al discloses a single pass wet fabrication process for preparing a gas diffusion electrode for metal-air fuel cell batteries.

U.S. Patent No. 5,306,579 to Shepard et al. discloses in Figs. 3 and 4 a metal-air fuel cell battery system 40 having a bifunctional metal-air electrode (i.e. cathode) 10 and a zinc anode 43 (as disclosed in US Patent No. 4,957,826), and an electrolyte disposed in a cell case 46. As disclosed in Figs. 1 and 2, the air-cathode 10 comprises an active layer 13 formed about a current collector 16 and a wet-proofing layer 19 laminated to the active layer 13. The current collector has a lead 22 which extends from the metal-air electrode 10. The active layer 13 of the air electrode 10 includes a first sublayer 25 and a second sublayer 28 packed between the first sublayer and the wet-proofing layer 19. As shown in Figs. 3 and 4, the zinc anode 43 is wrapped up in a sheet 49 of absorbent wettable, oxidation-resistant cloth, soaked in an electrolyte, and includes a metallic current collection screen which has a lead 52 extending from the cell base 46. As disclosed in Col. 9, at lines 30-35, the metal-air fuel cell battery 40 may be provided with air-cathodes on opposite sides of a single anode.

U.S. Letters Patent No. 5,260,144 to O'Callaghan discloses a metal-air battery comprising an air cathode having opposed surfaces supported for simultaneous exposure of a first surface to air and a second surface to liquid electrolyte. A metal anode is positioned in spaced juxtaposed relation to the second cathode surface to define therewith an anode-cathode gap for receiving electrolyte to form an anode-cathode pair electrically coupled by electrolyte. As disclosed, the metal-air battery contains an alkaline electrolyte and seed particles adapted to decrease passivation of the anode during discharge of the battery.

U.S. Letters Patent No. 5,250,370 to Faris discloses a metal-air fuel cell battery system in which a supply of metal fuel tape is recharged by a plurality of recharging heads having a total surface area which is substantially greater than the total surface area of the discharging cathode, so as to reduce discharging time.

U.S. Letters Patent No. 5,242,765 to Naimer et al. discloses a gas diffusion electrode containing a fiber reinforced composite structure in a layer thereof, the structure comprising structurally intact fibers precoated with sinterable polymeric material, which material is heat sintered, whereby the fibers are bonded to each other and to other components of the structure by the sintered polymeric material, while maintaining their individual fibrous structure and strength.

U.S. Letters Patent No. 5,196,275 to Goldman et al. discloses an electrical power storage unit having one or more metal-gas electrical cells, each cell including a pair of generally planar outer electrode units configured to define therebetween an interior space for containing an electrical power storage medium and an inner electrode unit mounted between the pair of outer electrode units so as to be in electrically conductive contact with the electrical power storage

medium and define a plurality of volumes each having a pair of open ends, each open end facing an adjacent outer electrode unit. The power storage medium is a slurry containing active metal particles and an electrolyte solution. The inner electrode unit is configured for removable insertion within the interior space. The volumes defined by the inner electrode unit are configured so as to contain portions of the power storage slurry such that removal of the inner electrode unit from the interior space causes the simultaneous removal therefrom of the major part of the power storage slurry. Each outer electrode unit includes a generally planar gas electrode, a device for separating the metal particles from the gas electrode, and a device for preventing mechanical damage to the device for separating upon removal of the inner electrode unit from the interior space and upon insertion of the inner electrode unit into that space.

U.S. Letters Patent No. 5,190,833 to Goldstein et al. discloses an electrode for use in a metal-air battery (or in a hydrogen-oxygen fuel cell) comprising a current-collecting metallic structure and a metallic foamed or fiber mat . a surface of the mat being impregnated with an inner hydrophobic waterproof barrier coated with an outer active catalytic layer.

U.S. Letters Patent No. 5,185,218 to Brokman et al. discloses an air cathode in combination with an oxygen-rich electrolyte-immiscible organic fluid or supplying oxygen thereto.

U.S. Letters Patent No. 5,121,044 to Goldman discloses an electrical energy system including an electric utility having an electricity generating apparatus and distribution lines, a plurality of electric vehicles and electric power storage apparatus receiving electrical power from the electric utility and supplying electrical power to the plurality of electric vehicles and to the electric utility when required.

U.S. Letters Patent No. 4,968,396 to Harvey discloses a hydrocarbon-combusting type fuel cell which comprises cylindrically-shaped platinum cathodic and zinc anodic elements that are movably and continually contact and circulate the fuel, in order to giving rise to evenness in ignition and completion of combustion with elimination of noxious by-products largely by combination with the hydroxyl ions formed by catalytic action.

U.S. Patent No. 4,957,826 to Cheiky discloses a metal-air fuel cell battery power system for powering an electrical device. As disclosed, the system comprises an enclosed container having an air inlet, an air outlet, and an array of connected metal-air battery cells contained therein. The container is sealed during non-use. When a power switch is turned on, the air inlet and air outlet are opened. At the same time, the residual low power of the metal-air battery cells is used to start a fan positioned near the air inlet. The fan initiates an air flow across the metal-air battery cells to further increase the power supply output. The power supply output is limited to the use requirement of the device by varying the fan speed in response to instructions from the device. Precise control of the battery cells' exposure to the air extends the lifetimes of the metal-air battery cells.

U.S. Patent No. 4,950,561 to Niksa et al. discloses a metal-air battery comprising one or more cells, wherein each cell includes a cell frame with an air-cathode attached to each face thereof. As disclosed, an anode blank is inserted through an access opening into the space formed between the air-cathodes. The anode blank comprises an elastomeric rubber labyrinth seal molded to the blank and sealing the access opening. As disclosed, a mechanism can be provided to circulate electrolyte (e.g. aqueous solution of an alkali hydroxide) into and out of the spaces between the anode and air-cathodes.

U.S. Letters Patent No. 4,916,036 to Cheiky discloses a metal-air fuel cell battery system, in which a consumable anode made of reactive material (e.g. lithium) is provided as a layer on a flexible conductive substrate realized in the form of an elongated tape wound on a reel. The anode tape is fed from the reel into and through an elongated electrolyte reaction chamber formed between the surface of the anode tape and the opposed cathode element. As disclosed, the ends of the compartment contain seals for retaining electrolyte between the electrodes (i.e. cathode and anode tape), and the anode tape is rewound on motor-driven take-up reel.

U.S. Letters Patent No. 4,913,983 discloses a metal-air battery power supply for powering a device, including an enclosed container having an air inlet, an air outlet, and an array of connected metal-air battery cells therein. The container is sealed during non-use. When a power switch is turned on, the air inlet and air outlet are opened. At the same time, the residual low

power of the battery cells is used to start a fan positioned near the air inlet. The fan initiates an air flow across the battery cells to further increase the power supply output. The power supply output is limited to the use requirement of the device by varying the fan speed in response to instructions from the device. Precise control of the battery cells' exposure to air extends the lifetimes of the cells.

U.S. Letters Patent No. 4,828,939 to Turley et al. discloses a bipolar metal-air battery assembly comprising a consumable metal anode type. As disclosed in Fig. 2, physical contact between internal metal-air battery elements is enhanced by air assisted, internally exerted compressive force. As disclosed, battery elements are constructed in modular manner which assists in the ease of battery assembly and disassembly such as when the anode elements need to be replenished. Also, a multitude of individual metal-air battery cells can be joined together in an efficient bipolar assembly cell stack for augmented electrical energy generation.

U.S. Letters Patent No. 4,714,662 to Bennett discloses a metal-air power module comprising a plurality of power cells arranged in a longitudinal stacked relation. Each power cell includes a frame, a gas-consuming cathode (e.g. air cathode) supported at one end of the frame and a consumable anode supported intermediate the ends of the frame by a flexible diaphragm spanning the frame. The diaphragm divides the frame into a chamber for the introduction thereinto of an electrolyte between the anode and the cathode, and an expansion chamber of the opposite side of the anode for the introduction thereinto of fluid under pressure. The pressurized fluid biases the anode toward the cathode during anodes consumption, and the diaphragm provides for longitudinal and angular movement of the anode to accommodate uneven corrosion of the anode. The frames of adjacent cells define a third chamber therebetween for the introduction of consumable gas to the cathode. An array of manifolds are formed throughout the frames of adjacent power cells for introducing electrolyte between the anode and the cathode, for introducing consumable gas to the cathode and for introducing fluid under pressure to the expansion chamber.

U.S. Letters Patent No. 4,693,946 to Niksa et al. discloses a battery assembly comprising a consumable metal anode which can be readily assembled and disassembled. The assembly has an open-structure, non-consumable anode cage which has an open top for facilitating the insertion of an anode. A modular air cathode is used, comprising a peripheral current conductor frame clamped about a grid reinforced air cathode realized in sheet form. As disclosed, the cathode frame can be sealed, during assembly, with electrolyte-resistant-sealant as well as with adhesive. The resulting cathode module can be assembled outside the cell body and readily inserted therein, or can later be easily removed therefrom.

U.S. Letters Patent No. 4,689,531 to Bacon discloses an apparatus and method for providing electrical regeneration in an electrical vehicle. An electric drive motor drives the vehicle and is powered from a bank of drive battery packs. An electric recharge motor drives a plurality of generators to recharge all of the batteries. The recharge motor is powered from a bank of recharge battery packs. Drive battery packs are paired together with recharge battery packs. A timer switch opens and closes electrical contact between each pair of battery packs and its corresponding electric motor, one pair at a time. Thus, a drive battery pack powers the electric drive motor while a recharge battery pack powers the electric recharge motor. Non-connected battery packs are recharged by the plurality of generators. The timer switch sequentially switches through all pairs of battery packs in such a fashion that each pair of battery packs is recharged for a longer period of time than it is discharged.

U.S. Patent No. 4,626,482 to Hamlen et al. discloses a two-cell metal-air battery installed within an emergency lantern. As disclosed in Fig. 3 and Column 6, a metal-air battery has an anode-cathode package 16 having an electrically nonconductive frame 26, wherein a pair of air cathodes C, C are attached thereto in opposed, mutually spaced relationship. In combination with the cathodes C, C, the frame forms a liquid-tight air chamber 30, to prevent entry of electrolyte fluid into the chamber. Air chamber 30 communicates with the ambient atmosphere through vent 20. As disclosed, an electrically nonconductive baffle 32 may be disposed in the air chamber, if desired, to prevent any fluid that should happen to enter the air chamber from providing a current path between the cathodes.

U.S. Letters Patent 4,560,626 to Joy discloses a metal-air/metal-oxygen fuel cell having a metal anode which cooperates with two air cathodes, and can be replaced when consumed. As disclosed, the air cathodes are urged toward opposite faces of the metal anodes at a constant and

uniform force. The associated cathodes are automatically retractable to permit the consumer anode remains to be removed from the housing and a new anode inserted between the two cathodes.

U.S. Letters Patent No. 4,551,399 to Despic discloses a bipolar metal-air battery having multiple cells inserted within spaced-apart cell walls 16. As disclosed, electric contact is established between the anode of one cell and the cathode of the adjacent cell through the wall which separates the two cells.

U.S. Letters Patent No. 4,341,847 to Sammells discloses a zinc-oxygen fuel cell comprising annular electrodes (i.e. zinc anode and air/oxygen cathode). As disclosed, oxygen flows through the central portion of the air-cathode) while a liquid electrolyte flows between a separator surrounding the air cathode and the concentric zinc anode is spaced from the separator. As disclosed, the metal-air fuel cell may be recharged electro-chemically, or alternatively, the active zinc particles in the electrolyte may be replenished as required.

U.S. Letters Patent No. 4,331,742 to Lovelace, et al. discloses an oxygen/hydrogen fuel cell which produces electrical power through the recombination of oxygen and hydrogen. As disclosed, the fuel cell includes a solid (gas-conductive) electrolyte body 20 having mutually spaced surfaces on which a multiplicity of mutually spaced cathodes 34 and anodes 36 are deposited in bar-like configurations, as shown in Fig. 2. As disclosed, strips of bare electrolyte substance 38 are interposed between cathode and anode strips, so that currents of ionic gas may be established between these electrodes via the bare strips of electrolyte material, thereby lowering the electrical resistance of the cells while enhancing the gas conductivity.

U.S. Patent 4,246,324 to de Nora et al. discloses a metal-air fuel cell battery system comprising an container housing a plurality of gas depolarized metal cathode elements in hollow box-like form, and consumable anode elements in spaced relationship with the cathode elements. At least one wall of each cathode element has a gas-permeable porous cathode formed of sintered particles impregnated with a catalyst and, on the inside, with a hydrophobic resin. The consumable anode elements are mounted on non-consumable metal supports so as to be removable (with or without their supports) and replaceable in the container. In operation, depolarizing gas is fed inside the cathode elements and an electrolyte is maintained between the facing cathodes and anodes.

U.S. Letters Patent No. 4,172,924 to Warszawski discloses a metal-air fuel cell battery system comprising an oxygen-reducing electrode (i.e. air-cathode), an ion pervious insulating membrane adjacent thereto, a metal-oxide paste containing particles of an oxidizable metal and a liquid electrolyte, and a inert electrode (i.e. anode) arranged in physical contact with the metal-oxide paste. The metal paste is moved from a first reservoir through the electrochemical battery, wherein it is oxidized to the corresponding metal-oxide paste and passed onto a second reservoir. The battery system may be recharged by reversing the movement of the metal-oxide paste and electrolyzing or reducing the metal-oxide paste in an external circuit.

U.S. Letters Patent No. 4,152,489 to Chottiner discloses in Fig. 1, a metal-air battery system 10 comprising bifunctional and unifunctional metal-air cells. As disclosed, the system comprises a casing 11 for supporting a pair of air-cathodes 12 and 13, a fuel electrode (i.e. metal-anode) 27, and an electrolyte 29. Each air-cathode 12 and 13 has an outer hydrophobic layer 14 and 16, respectively, which may be in contact with the atmosphere or other source of air or oxygen. Air-cathodes 12 and 13 also include hydrophilic sections 17 and 18, respectively, each hydrophilic section consisting of a plurality of thin, laminated, active material loaded plaques. These sections include integral metal current collectors 19 and 21. Electrodes 12 and 13 are framed in frames 22 and 23, preferably made from ABS plastic and have electrical leads 24 and 26, respectively. As disclosed, the metal-air system 10 includes a fuel electrode 27, fabricated from iron, cadmium, zinc or the like material, preferably iron, spaced between air-cathodes 12 and 13 and including electrical lead 28. The electrolyte 29 comprising an alkali hydroxide, preferably potassium hydroxide, is disposed between and in contact with the metal fuel anode 27 and air cathodes 12 and 13, respectively.

U.S. Letters Patent No. 4,052,541 to Von Krusenstierna discloses an electric accumulator-type cell comprising a dissoluble electrode (e.g., a zinc electrode) and a counter-electrode (e.g., nickel electrode). The dissoluble electrode is formed by a central layer having outer layers disposed on either side thereof. The outer layers are generally smaller in planar size than the

central layer and preferably all of the layers are porous, perforated or netlike. As disclosed, the dissoluble electrode and/or separator disposed between the dissoluble electrode and counter-electrode are vibrated in the plane of the electrode so as to minimize dendrite growth and shaping of the deposited active material, and thus improving the life of the cell.

U.S. Patent No. 3,977,901 to Buzzelli, like US Patent No. 4,152,489 to Chottiner, discloses a metal-air battery system 10 comprising bifunctional and unifunctional metal-air cells. As disclosed, the system comprises a casing 11 for supporting a pair of air-cathodes 12 and 13, a fuel electrode (i.e. metal-anode) 27, and an electrolyte 29. Each air-cathode 12 and 13 has an outer hydrophobic layer 14 and 16, respectively, which may be in contact with the atmosphere or other source of air or oxygen. Air-cathodes 12 and 13 also include hydrophilic sections 17 and 18, respectively, each hydrophilic section consisting of a plurality of thin, laminated, active material loaded plaques. These sections include integral metal current collectors 19 and 21. Electrodes 12 and 13 are framed in frames 22 and 23, preferably made from ABS plastic and have electrical leads 24 and 26, respectively. As disclosed, the metal-air system 10 includes a fuel electrode 27, fabricated from iron, cadmium, zinc or the like material, preferably iron, spaced between air-cathodes 12 and 13 and including electrical lead 28. The electrolyte 29 comprising an alkali hydroxide, preferably potassium hydroxide, is disposed between and in contact with the metal fuel anode 27 and air cathodes 12 and 13, respectively.

U.S. Patent No. 3,963,519 to Louie discloses a metal-Air cell comprising an anode, a cathode, and an electrolyte. As disclosed, the anode comprises a consumable porous metal and the cathode comprises a hydrophobic member in contact with an electrocatalyst. These components are retained in a substantially rigid protective shield and spaced therefrom permitting access of air to the cathode over substantially the entire cathode surface area. The electrolyte can be a solution or paste of an ion-conductive material or a water-activatable solid, such as "dry" potassium hydroxide adhering to or absorbed in the anode and/or cathode and/or a hydrophilic separator between the anode and cathode.

U.S. Letters Patent No. 3,928,072 to Gerbier et al. discloses an air depolarized electric cell comprising a negative electrode occupying a peripheral position, an electrolyte which is preferably gelled, and a positive electrode mass occupying a central position within the negative electrode. The positive electrode is provided with a funnel in the center of the positive mass and with a metallic current collector disposed in the funnel in contact with walls of the funnel. The collector comprises a metallic wire in the form of a helix at least partially incrusted or embedded in the wall of the funnel.

U.S. Letters Patent No. 3,909,685 to Baker et al. discloses a electrical apparatus wherein a plurality of batteries, for example, are controllably interconnected to form a power unit which accepts electric energy in a charging mode and feeds a load in a discharging mode. Controllers act through switches to interconnect the batteries in a way that permits them to accept unrectified electric energy from an a-c primary source the voltage and frequency of which may be variable; the energy is accepted over a substantial portion of the power cycle and the rate of charging is controllable; the controllers also interconnect the batteries in a way that permits the power unit to deliver energy to a load at a specified voltage and frequency. The power unit output can, for instance, be 60 cycle a-c, single or three phase. Thus, for example, the primary source can be a windmill-powered or water-powered generator whose output is a sinusoidal voltage that varies with wind or water velocity both in voltage and frequency and the power unit (or more probably a plurality of power units) can be used to provide 60 cycle single phase voltage for domestic use. In general, the batteries are charged in series and a controlled charging rate is maintained by a novel scheme for interconnection in a programmed fashion. The power unit can accept electric energy and feed a load as alternate conditions of operation, or a plurality of power units can be used to give simultaneous charge and feed; and the power unit can be employed as a substitute for the generator or other primary source, that is, to perform the function of an uninterruptable power supply (UPS). As a further example, the concept of changing roles can be employed in electric vehicle drives wherein the power unit electrically powers an a-c electric machine which acts as a motor during acceleration of the vehicle and as a generator during deceleration; the power unit feeds the motor at a variable voltage and variable frequency and accepts electric energy from the generator, again at variable voltage and variable frequency.

U.S. Letters Patent No. 3,845,835 to Petit discloses an electric power plant for a land vehicle which includes: an electric motor; two alternators driven by the motor; a voltage regulator for the alternators; and two sets of batteries charged alternately through the regulator. The battery

that is not being charged energizes the motor. The alternators are on the drive axle of the vehicle.

U.S. Letters Patent No. 3,822,149 to Hale discloses a rechargeable zinc-air cell and battery which comprises: a circular casing having a circular reservoir with electrolyte contained therein; a rotatable electrode, having at least one planar zinc surface, enclosed coaxially in the reservoir; a stationary planar counter-electrode spaced from the rotatable electrode; wiper means disposed between the electrodes for lightly abrading the zinc surface; and means for agitating the electrolyte to maintain particulate matter in suspension.

U.S. Letters Patent No. 3,717,505 to Unkle et al. discloses a cell stack comprising a plurality of individual frames made from electrically insulating material, each having a cavity extending transversely therethrough and separate elongated supply and return electrolyte passageways leading to and from the cavity. An electrode assembly is disposed in a recess provided in one surface of one of the frames and sandwiched between it and another frame.

U.S. Letters Patent No. 3,663,298 to McCoy et al. discloses an electrode structure for use with an electrolyte wherein an electrically conductive flowing particle bed stream within a compartment of the electrode structure establishes a plurality of electrochemical reaction sites at the interface of the particles and of the electrolyte. As disclosed, the flowing particle bed electrode structure can be an electrode in an electrically regenerable system, i.e. as a rotatable zinc electrode in zinc-nickel oxide and zinc-air secondary cells.

U.S. Letters Patent No. 3,577,281 to Poutney et al. discloses a rechargeable cell which comprises, in a charged state, a bulk aqueous electrolyte of potassium hydroxide saturated with zinc oxide; a cathode; and an anode comprising a long steel tape coated with zinc on its active surface. The tape is driven from a storage reel through a region in the electrolyte adjacent to the cathode, and onto a takeup reel, at speeds dependent on the load current or voltage, or both. During charging, the tape is driven in the opposite direction. The cathode may be a stationary air permeable electrode; or it may comprise a tape similar to the anode and tape and similarly driven, coated with silver oxide on its active surface.

U.S. Letters Patent No. 3,536,535 to Lippincott discloses a zinc-air storage batteries comprising consumable anodic material in the form of individual flat rectangular metal bars attached parallel to one another by an insulating material to form a flexible chain or track movable in a continuous path between adjacent cathode plate structures. As disclosed, the elongated strip conductors disposed along the path contact the edges of the individual bars as they move between adjacent pairs of cathode plate structures for multicell operation, and flexible wipers disposed at intervals along the path bear against the opposing air surfaces to scrape or brush foreign material and reactive product deposits therefrom as the bars move past so as to maintain the anode surfaces free of harmful deposits that prevent or inhibit further operation.

U.S. Patent No. 3,532,548 to Stachurski discloses a high-energy electrochemical cell utilizing three electrodes: a positive first electrode having a porous body consisting at least in part of carbon, silver, platinum or palladium for promoting the reduction of oxygen upon the introduction of an oxygen-containing gaseous fluid into the pores of the electrode body; a negative rechargeable second electrode containing as its active material an oxidizable base metal, e.g. zinc, cadmium, iron or tin; and a third positive rechargeable third electrode of the type conventionally employed in a current-producing couple with an electrode of the type of the second electrode. As disclosed, the gas (oxygen) electrode may include porous high-density carbon plates impregnated with a suitable catalyst, porous sheet silver or sintered silver, a catalyst spread upon a thin porous wire mesh, all of which may be treated to make them appropriately hydrophobic, i.e. with Teflon.

U.S. Letters Patent No. 3,454,429 to Gruber discloses a fuel cell system, in which moving electrode separator tapes 10 and 11 are moved past electrode fuel source valve outlets 14 and 15 between electrodes 12 and 13, respectively.

U.S. Letters Patent No. 3,436,270 to Oswin et al. discloses an metal-oxygen cell comprising a zinc anode which, when completely or substantially oxidized to the oxide, the anode is replaced by loosening clamping means on the battery, removing the anode and inserting a new anode. As disclosed, new electrolytes are furnished to the cell at the time the anode is replaced, for example, saturating a porous anode, and/or a hydrophilic membrane around the anode.

U.S. Letters Patent No. 3,432,354 to Jost discloses an electrochemical power supply comprising a body of aqueous electrolyte, electrically conductive air/oxygen cathode, a supply of elongate electrically conductive porous anode material (in the form of tape), and a mechanism for moving this anode material relative to the cathode and through the aqueous electrolyte.

U.S. Letters Patent No. 3,357,864 to Huber discloses in Figs. 1-3 several types of electrochemical cells, in which the anode material, in the form of foil material, is kept and stored in a wound up condition on a rotatable shaft and, when the cell is activated, the anode material is unwound and drawn into the electrochemical system by turning the rotatable shaft.

U.S. Letters Patent No. 3,260,620 to Gruber discloses an fuel cell system in which moving separator tapes are used to carry the electrolyte, metal fuel, and oxidant elements of the system during electrical power generation.

U.S. Letters Patent No. 3,252,838 to Huber et al. discloses a fuel cell comprising rotary electrodes which produces a current having an intensity which varies periodically between a maximum value and a minimum value such as zero so as to permit the use of a voltage step-up transformer to convey electrical energy in certain applications.

UK Patent No. 1,176,488 to Leesona Corporation discloses in Fig. 1 and on page 1, a metal/air or metal/oxygen electrochemical battery having a plurality of electrochemical cells having consumable anodes and air or oxygen depolarized cathodes, wherein the access of air or oxygen to the cells is obstructed when the battery is not in use. As disclosed, the plurality of cells are spaced apart by inter-cell spacers having openings therein to permit access of air to the cells. Each cell comprises a metal anode located within an envelope cathode and an electrolyte located in the space between anode and cathode. The ports are openable and closeable by slides formed with apertures which are movable into and out of registration with the ports. The ports are arranged in rows and each row is provided with a slide formed with apertures which are movable simultaneously into and out of registration with the ports of the row by movement of its slide.

Maxim Integrated Products, Inc.'s website Application note entitled "Convert 3V to 5V without inductors" discloses circuitry for maintaining a regulated 5V from an input voltage source of 3V.

Maxim Integrated Products, Inc.'s website Application note entitled "Derive 5B Four AA Cells" discloses circuitry for converting battery voltage from four (4) AA cells (in the 6V to 4V range) to a regulated 5V and -5V. An inductive element is used to generate an additional supply voltage (-5V or 5V) from the regulated output voltage levels (5V or -5V).

Maxim Integrated Products, Inc.'s website Application note entitled "Boost/Linear Regulator Derives 5V From Four Cells" discloses circuitry for maintaining a regulated 5V from a voltage input source in the range from 3V to 10V.

The white paper entitled "Fuel Cell Technology and Applications" provides a diagrammatic view of a zinc-air fuel cell and accompanying description of the chemical processes of the operation of the zinc-air fuel cell.

Chapters 4.8.1-4.8.2 "Metal-Air Batteries/Zinc-Air Batteries" of the book "Fuel Cells and their Applications" describes the development of mechanically rechargeable zinc-air batteries. One of the zinc-air batteries described therein (developed by Electric Fuel Corporation) packages each zinc anode in a "cassette" holding a zinc/zinc oxide slurry in tight contact with a zinc anode plate. The cassettes are withdrawn in a machine.

The Applied Physics Letter publication "Fabrication Of Thin-Film LiMn2O4 Cathodes For Rechargeable Microbatteries" discloses a method of making thin-film cathodes of lithiated manganese oxide for use in thin-film secondary batteries in wireless telecommunications and emerging integrated optoelectronic circuits.

The 1991 Popular Mechanics article "New Age EVs" by Berb Shuldiner discloses the use of fuel cell batteries in modern electric vehicles, and how various types of battery technologies compare in terms of battery power, range and recharge life potential.

The 1991 Popular Mechanics article "Battery Chargers: We Go On-Track in the First Race

For Electric Cars" by Mike Allen, discloses experimental use of zinc-air batteries in electric vehicles by DEMI Honda.

Pages 6-28 of a 1991 Marketing Study by AER Energy Resources, Inc. discloses a comparison of operating characteristics of various battery technologies, as well as system details for several rechargeable zinc-air battery technology products developed by AER (at pages 20-25)

The 1991 Popular Science article "Electric Car Showdown In Pheonix; Zinc-Air Battery Wins" discloses the use of zinc-air battery technology from Dreisbach Electromotive, Inc. (DEMI) to power electric vehicles.

The white paper entitled "LBL RESEARCHERS WORK ON NEW GENERATION OF BATTERIES" describes research involving the development of a zinc/nickel-oxide battery and a zinc-air battery. The zinc-air battery includes an anode that is honeycombed and reticulated, with a sponge-like configuration that extends the capacity of electrode by increasing the area involved in the electrochemical reaction. The open structure allows electrolyte to flow through it, circulated by a small, external electric pump. The pump stirs and mixes the electrolyte so that even concentrations of ions are maintained throughout the flow. This even flow allows the anode to be replated with zinc in a uniform manner during charging, and allows ions to flow evenly along the entire front between the electrodes during discharging. In order to ward off dendrites, an inert coating is applied to the exterior surface of the sponge-liker anode. The inert coating reduces the capacity of the cell, which is compensated for by the maze of zinc surfaces within the interior of the anode. The air cathode is fabricated by soaking a "cardboard" substrate in a polymer and subjected to very high temperatures. The resultant structure is a conductive, fibrous, graphic-like structure. The top surface is metalized by coating it with a nickel-oxide catalyst which is mixed with Teflon. Teflon is inert, porous and non-wettable, and creates spaces in the metallic coating through which the cathode interacts with outside air, thereby allowing gas to diffuse and convert to soluble ions as it passes through the air cathode.

Chapter 3 "Zinc-Batteries" in the textbook "Batteries for Cordless Appliances" by R. Brood discloses the basic chemistry underlying metal-air batteries as well as the operating characteristics of several prior art systems.

A separate listing of the above references on PTO Form 1449 and a copy of these references are enclosed herewith for the convenience of the Examiner.

The Commissioner is hereby authorized to charge any fee deficiencies to Deposit Account No. 16-1340. A copy of this documents is enclosed herewith.

Respectfully submitted,

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